The Macroinvertebrate Communities of the Great Swamp Watershed

Part II: Summer, 2012: Results

A Report to the
Ten Towns Great Swamp Management Committee

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Macroinvertebrate Communities of the Great Swamp, 2012 Results

Executive Summary

In late May, 2012, sampling of macroinvertebrate (MIV) communities was performed at 17 sites spread among the 5 streams that drain the Great Swamp Watershed. The beginning months of 2012 were considerably warmer and drier compared to average conditions, but the late-summer/early fall of 2011 was exceptionally wet – including the contribution by Hurricane Irene. Between 9 - 4 on May 25, 2012, we used field meters to monitor temperature, dissolved oxygen (DO), pH, total dissolved substances (TDS), and turbidity at all 17 sites. We also completed an EPA "high gradient" habitat assessment form (Barbour et al., 1999) at each site.

High TDS values continue at all stations on Loantaka Brook (highest toward its source), although this year, values were the lowest seen in the past several years. The dry preceding spring no doubt accounts for this**.** TDS readings also continue to be high at BB2 (555 mg/L below the Chatham Township Sewage Treatment Plant) and at upper Great Brook sites (381 mg/L at GB5 just below Foote's Pond in Morristown, but a record high of 419.1 mg/L at GB4).

This year turbidity was especially high (3 times the average) just below Silver Lake at GB3, and high readings persisted downstream to GB2. To some lesser degree, turbidity jumps were also seen below Osborn Pond at PR1, Foote's Pond at GB5, and Kitchell Pond at LB2. Highest temperatures were associated with sites just below dammed impoundments that lack sunlight-buffering canopy cover. This occurred at BB1 (golf course hazard pond), LB2 (below Kitchell Pond), GB5 (below Foote's Pond in Morristown), and PR1 (below Osborn Pond). For the third year in a row, BB1 had very low dissolved oxygen. Decomposition of organic debris and poor water- turnover account for this problem. As usual, the upper two Loantaka Brook sites, LB3 and LB4, scored worst in habitat quality, while upper Passaic River sites, PR3 and IG1 were highest.

A total of 3777 individuals were examined in 2011, representing 124 distinctive MIV types. Fluctuating numbers among the groups that often dominate macroinvertebrate communities continued in 2012. Simuliidae (blackfly) larvae included 629 individuals; Hydropsychidae caddisfly larvae – 650 individuals; and gammarid amphipods – 527 individuals.

Community quality, as reflected in B-IBI scores, matched (6 instances) or exceeded (1 instance - by just 2 points) 2011 results at 7 of our 17 sites, but fell below 2011 results at 10

sites. Scores fell across the board at Great Brook and Passaic River sites, by 4 or more points at 5 of those 7 locations. LB3 also fell by 6 points. Only the Primrose Brook sites held their own compared to 2011. Relative to 2000-2012 mean values, plus or minus 1 standard deviation, LB3, GB3, GB5, and PB2 were significantly low, while LB2 and LB4 sites fared much better than average.

2012 was a favorable year for blackfly larvae but not for its predator, *Cardiocladius*. In consequence, increases in the Dominance (DOM) component caused the Benthic Index of Biological Integrity (B-IBI) score (our measure of community "quality") to fall at all 4 Great Brook sites. A drop in the Proportion Predators (PPRED) component led to further declines at all GB sites except GB2. The MIV community at LB3, located below the Morris Township STP in poor substrate diversity, was dominated by enchytraid worms, accounting for more than ½ of the individuals encountered there. The absence of predators also pulled down its B-IBI Score. The PB2 MIV community was about equal to the comparatively poor one seen in 2011. Because of this lack of improvement, once again PB2 should receive special attention in the future.

Declines in community quality at PR2 (6 points) and PR1 (4 points) were substantial, although they remained within 1 standard deviation of their mean values. In 2012, apparently as a result of Hurricane Irene the preceding fall, all of the rocky substrate at the PR2 location (just downstream from I-287) had been washed downstream obliterating the MIV-favored riffle habitat. We suspect that high water flow here and further downstream at PR1 accounts for declines in MIV community quality as they attempt to recover from severe stream-bed scour.

Observing changes in B-IBI values for each site since 2000 shows that nearly all sites display B-IBI oscillation as components reflect observed changes in community composition over this period. Only the PB2 site, discussed above, declines in noteworthy fashion. In all but Great Brook sites, the degree of variability in B-IBI score appears to have reduced – especially since 2006 when sampling shifted to a slightly earlier date each year. A plot of average values for all the sites in each stream shows stream-wide trend lines for MIV communities continuing to improve at all Great Swamp watershed streams.

See Appendix 11-2 for Stream Summaries and suggestions for further action.

The 2012 Great Swamp Watershed Study

In late May, 2012, sampling of macroinvertebrate (MIV) communities was performed at 17 sites spread among the 5 streams that drain the Great Swamp Watershed. See Pollock (2000 and updates described in the Introduction in Pollock, 2012) for a complete description of the sampling sites and the methodology that was used during this survey (techniques based on the EPA Rapid Bioassessment Protocols (Barbour et al., 1999)).

Habitats & Environmental Monitoring

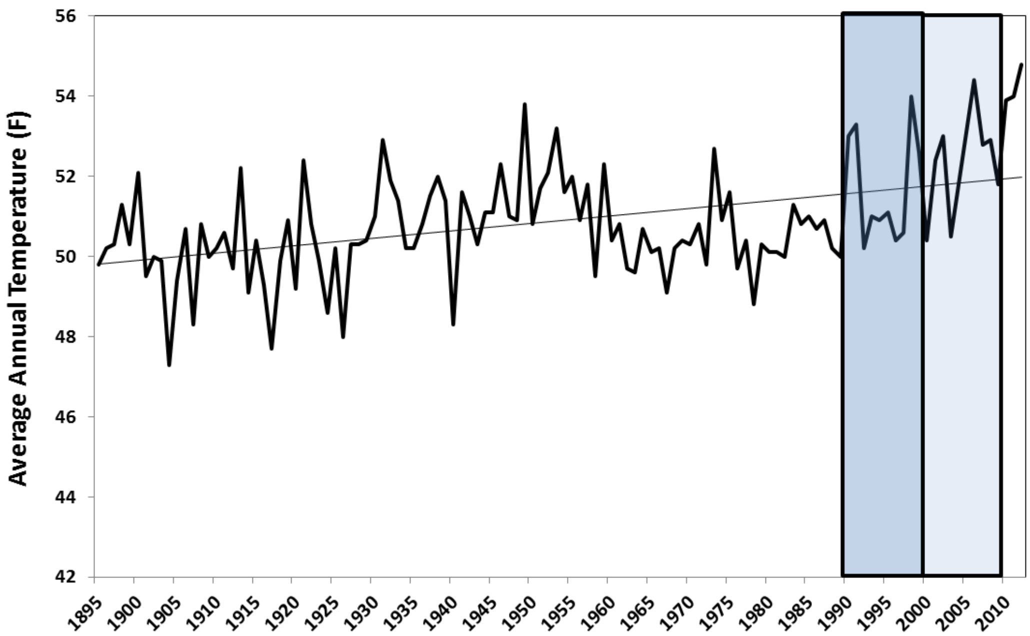
Environmental Observations

Habitat Conditions:

In past reports we have noted the upward trending patterns of temperature and precipitation over northern New Jersey since 2000. Here, in Figure 12-1a & b, we use the same data source (http://climate.rutgers.edu/stateclim _v1/data.html) to extend that view to show overall patterns in annual temperature and precipitation since 1895. Highlighted areas in these figures show that the 1990s (the decade preceding our study) were both cooler and drier than the 2000s (the decade that includes our studies). Despite annual ups and downs in individual years, we have offered this climate shift – especially toward increased precipitation - as a plausible explanation for the trend toward improvement in MIV communities that we have observed at most sites since 2000 (Pollock, 2011).

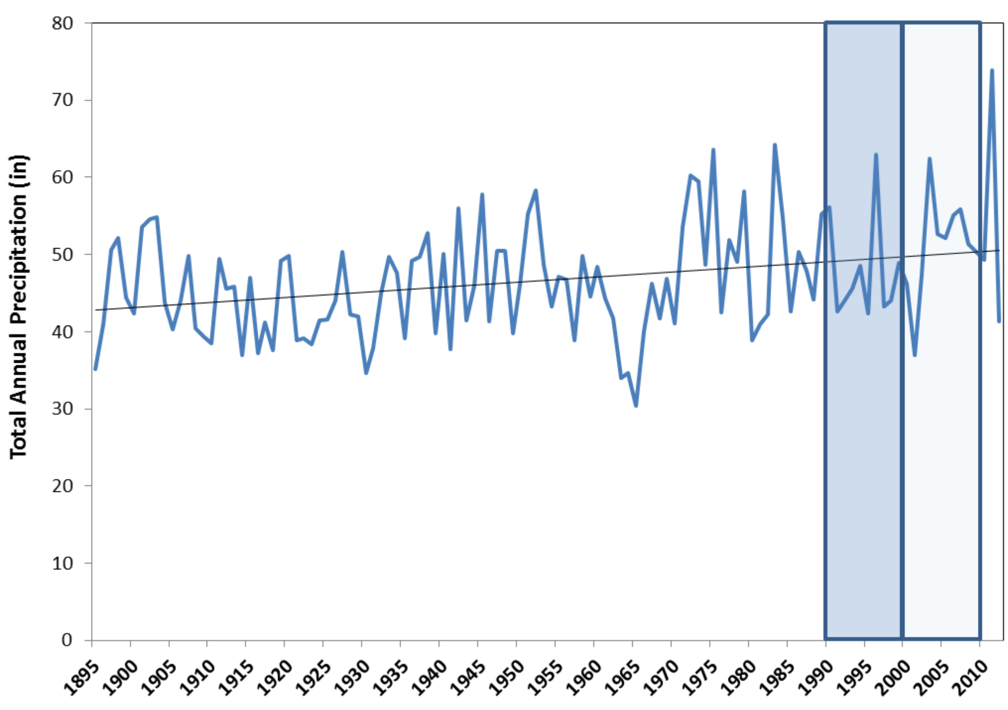
In Figures 12-2a & b, we can also view temperature and precipitation patterns from the perspective of monthly values. The overall mean monthly values (1895-2012) form a baseline against which mean values of monthly temperature and precipitation since 2005, and from the past two years, can be compared. For both climate variables, more recent amounts have been above average in nearly every month. There are a few noteworthy departures during the months preceding our 2012 sampling period. The first three months of 2012 were considerably warmer than average (Figure 12-2a). In addition, the period including February through April in 2012 was exceptionally dry compared to average conditions, while the late-summer/early fall of 2011 was exceptionally wet (Figure 12-2b) – including the contribution by Hurricane Irene. The nine months of precipitation extremes preceding the 2012 sampling period presented heavy stream-flow scouring followed by an unusually dry period.

Figure 12-1a. Northern New Jersey Average Annual Temperature (^oF)



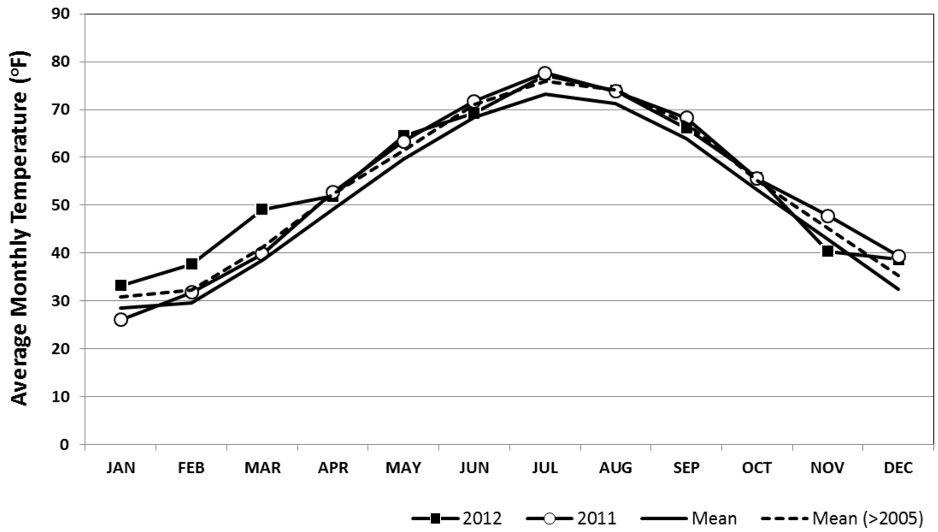
Source: http://climate.rutgers.edu/stateclim_v1/data/north_njhisttemp.html

Figure 12-1b. Northern New Jersey Annual Precipitation (in)



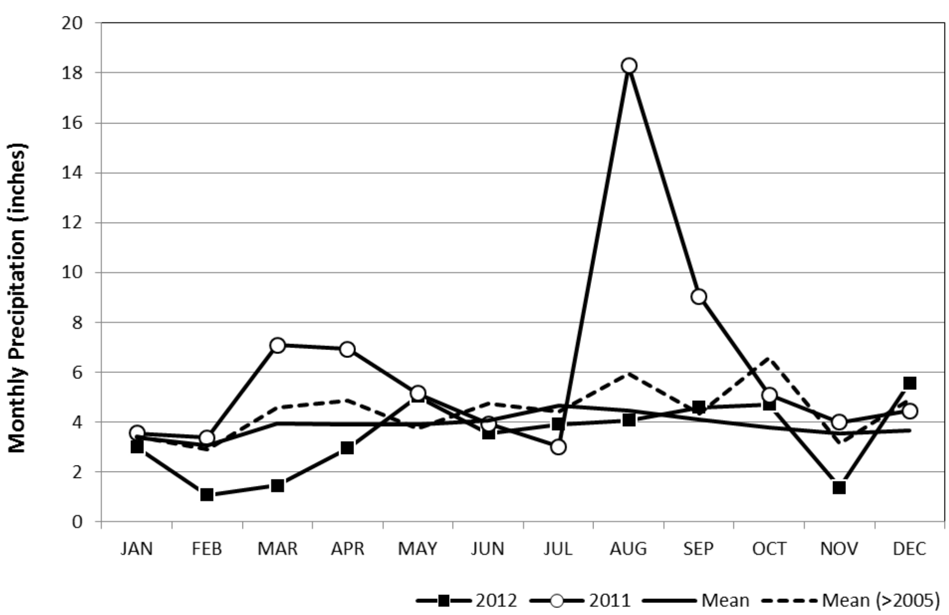
phttp://climate.rutgers.edu/stateclim_v1/data/north_njhistprecip.html

Figure 12-2a. Northern New Jersey Average Monthly Temperature (^{o}F)



Source: http://climate.rutgers.edu/stateclim_v1/data/north_njhisttemp.html

Figure 12-2b. Northern New Jersey Monthly Precipitation (inches)



Source: http://climate.rutgers.edu/stateclim_v1/data/north_njhistprecip.html

In her review of the *State of the Streams in the Great Swamp Watershed*, Laura Kelm (2013) describes a “big picture” view including more than a decade’s worth of monitoring research conducted on the watershed streams. The water chemistry portion of her report concentrates especially on nutrients (total phosphorus, dissolved reactive phosphorus, and total nitrogen). Levels of all three of these were highest by far in Loantaka Brook, especially in summer and presumably the result of fertilizer runoff. This work is important by promoting better understanding of the nutrient contribution to watershed steams to the stimulation of plant productivity in impoundments, and to downstream conditions in the Great Swamp Refuge and the Lower Passaic River beyond. At current levels, nutrients play an unknown but probably modest role in lives of stream MIVs by fueling diatom and algal growth on substrate surfaces and, in some cases, by supporting downstream productivity-overflow from several impoundments. Benthic and planktonic algae along with the organic detritus resulting from their eventual decay plus organic breakdown products from rooted aquatic vegetation are important energy sources fueling MIV communities. But in excess, these materials can join inorganic silt from runoff and contribute to the turbidity (loss of transparency) of flowing waters. This issue will be discussed further below.

She also included a review of data on total dissolved substances (TDS) and total suspended solids (TSS). She reported spikes in TDS during winter – associated with road de-icing applications, but also found that some contributors to TDS apparently can be stored temporarily in soils, only to be released in pulses by subsequent precipitation during the rest of the year. This confirms the on-going source of stress that we have suspected at high TDS sites on Loantaka, Great and Black Brooks as measured during our own early summer surveys. She reported that TDS levels at LB1 (the site with the *lowest* TDS in that stream) exceeded the NJ water quality standard of 500 mg/L 63% of the time. She found that TSS tended to be low with very few instances in which levels exceeded State Standards.

Between 9 am and 4 pm on May 25, 2012, we used field meters to measure temperature, dissolved oxygen (DO), pH, total dissolved substances (TDS), and turbidity at all 17 sites. We also completed an EPA "high gradient" habitat assessment form (Barbour et al., 1999) at each site. Refer to Table 12-1 for site-specific values for these variables. Table 12-2 shows three-year comparisons for key variables. Overall, temperature, TDS, and dissolved oxygen were slightly less than in the two preceding years, while turbidity was somewhat higher.

High TDS values continue at all stations along Loantaka Brook – highest toward it's source. This year, values were the lowest seen in the past several years (see Table 12-2). The dry preceding spring no doubt accounts for this**.** TDS readings also continue to be high at BB2 (555 mg/L below the Chatham Township Sewage Treatment Plant) and at upper Great Brook sites (381 mg/L at GB5 just below Foote's Pond in Morristown, but a site-record high of 419.1 mg/L at GB4). The New Jersey DEP water quality standard for surface waters sets a TDS limit of 500 mg/L for FW2-category waters (including all those in the watershed). High TDS at Loantaka and Great Brook sites are probably related to accumulated road salt de-icing applications. It continues to be disturbing to find values near or above the state limit in 3 Great Swamp streams well into the spring/summer period.

Suspended silt and detritus create turbidity and are transported by flowing streams where they can interfere with the sunlight penetration that stimulates the benthic diatom and algal growth that is used as MIV food sources. Also, in spots where the current slows, these fine particulates can settle out to clog pore spaces and restrict water circulation between bottom stones and sediments. MIV organisms rely on open substrate channels for subsurface access and for maintaining favorable dissolved oxygen levels. This year turbidity was especially high (3 times the average) just below Silver Lake at GB3, and probably related high readings persisted downstream through GB2. To some lesser degree, turbidity jumps were also seen below Osborn Pond at PR1, Foote's Pond at GB5, and Kitchell Pond at LB2. Impoundments slow current flow and can serve helpfully as "sinks" for sediments, resulting in clearer water conditions downstream. On the other hand, above average flow conditions can resuspend impoundment-stored sediments and spread them on their way downstream – a circumstance apparently effecting 4 watershed impoundments in 2012. Post-impoundment turbidity noted in these settings this spring are probably related in this way to the excessively wet preceding fall.

As in the past, highest temperatures were associated with sites just below dammed impoundments that lack sunlight-blocking canopy cover. This occurred at BB1 (golf course and hazard pond), LB2 (below Kitchell Pond), GB5 (below Foote's Pond in Morristown), and PR1 (below Osborn Pond).

For the third year in a row, BB1 had very low dissolved oxygen. This location has low volume, intermittent water flow and lies downstream from a very productive golf course water hazard. Decomposition of organic debris and poor water turnover account for this problem.

As usual, the upper two Loantaka Brook sites, LB3 and LB4, scored worst in habitat quality, while upper Passaic River sites, PR3 and IG1 were highest.

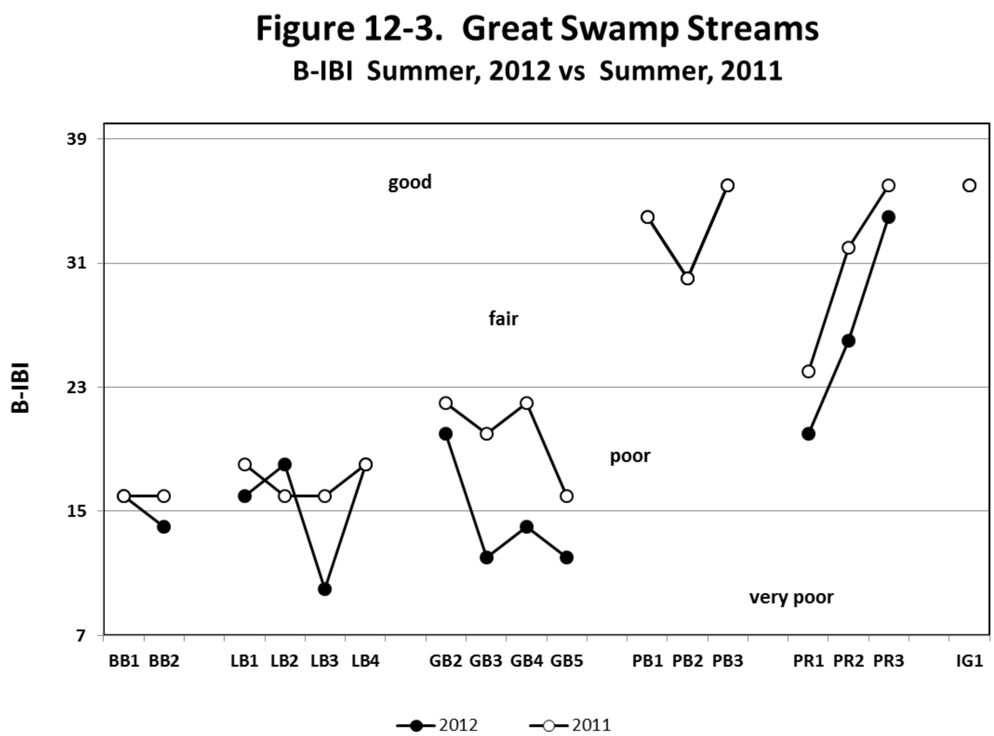
Macroinvertebrate Survey

Data in Appendix 12-1 show that a total of 3777 individuals (3789 in 2011) were examined in 2011, representing 124 distinctive MIV types (116 in 2011). Fluctuating numbers among the groups that often dominate macroinvertebrate communities continued in 2012. Simuliidae (blackfly) larvae included 629 individuals (268 in 2011, 632 in 2010); Hydropsychidae caddisfly larvae – 650 individuals (339 in 2011, 817 in 2010); and gammarid amphipods – 527 individuals (397 in 2011, 383 in 2010). However, we find no consistent patterns nor correlations among these organisms. Underlying factors stimulating these changes remain a mystery.

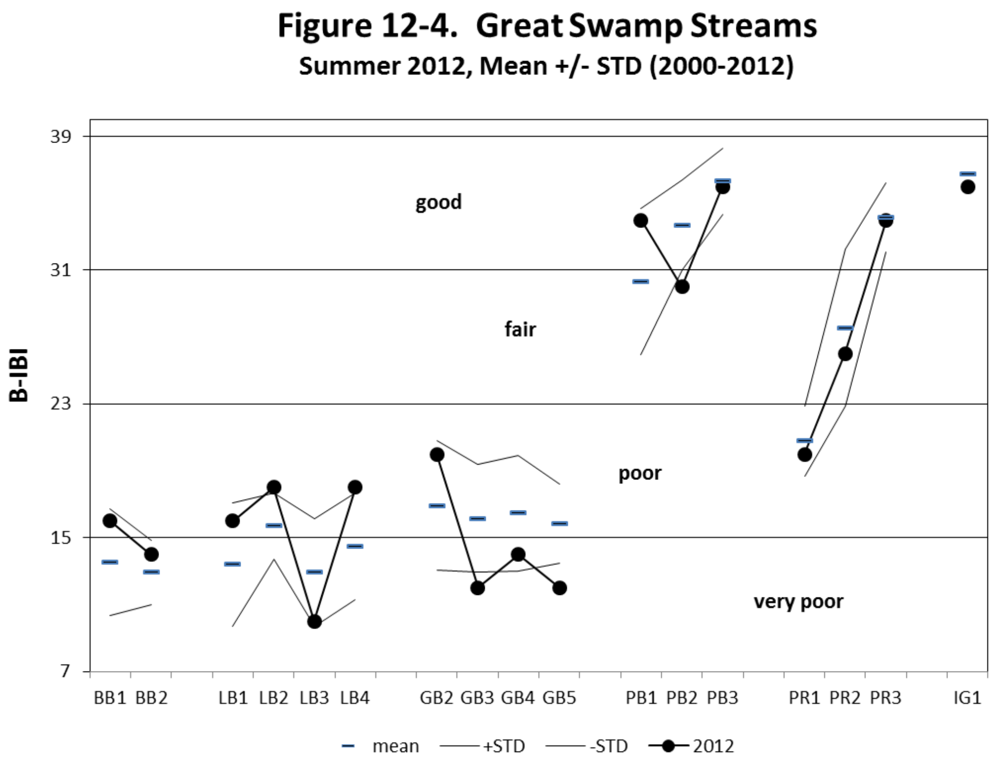
A site's Benthic Index of Biological Integrity score (B-IBI) can be considered a proxy for its "community quality". Using B-IBI values, the macroinvertebrate communities at sites can be described as "good", "fair", "poor", or "very poor". As a result of the scoring method used to calculate B-IBI values (see Pollock, 2003a), an annual change of just two points up or down can be considered to be minimal. An initial way to focus on "noteworthy" changes is to identify sites that show a change of four or more points in a year. Community quality, as reflected in B-IBI scores, matched (6 instances) or exceeded (1 instance - by just 2 points) 2011 results at 7 of our 17 sites, but fell below 2011 results at 10 sites (see Figure 12-3). Scores fell across the board at Great Brook and Passaic River sites, by 4 or more points at 5 of those 7 locations. LB3 also fell by 6 points. Only the Primrose Brook sites held their own compared to 2011. Specific causes of change in B-IBI scores between 2011 and 2012 can be explored in Table 12-3.

We can put the community changes seen in 2012 into broader perspective by viewing them, in Fig. 12-4, relative to 2000-2012 mean values, plus or minus 1 standard deviation. Using this criterion, LB3, GB3, GB5, and PB2 were significantly low, while LB2 and LB4 sites fared much better than average. All in all, 2012 results reversed many positive gains reported in 2011.

Combining these strategies for identifying sites for particular attention in 2012, we include LB3, GB3, GB4, GB5, PR1 and PR2 for their 4-or-more-point declines. While PB2 was unchanged from 2011, this score, more than 1 standard deviation below its mean score, is of concern. No unusual environmental circumstances among those that we observed at PB2 appears to account for this results.



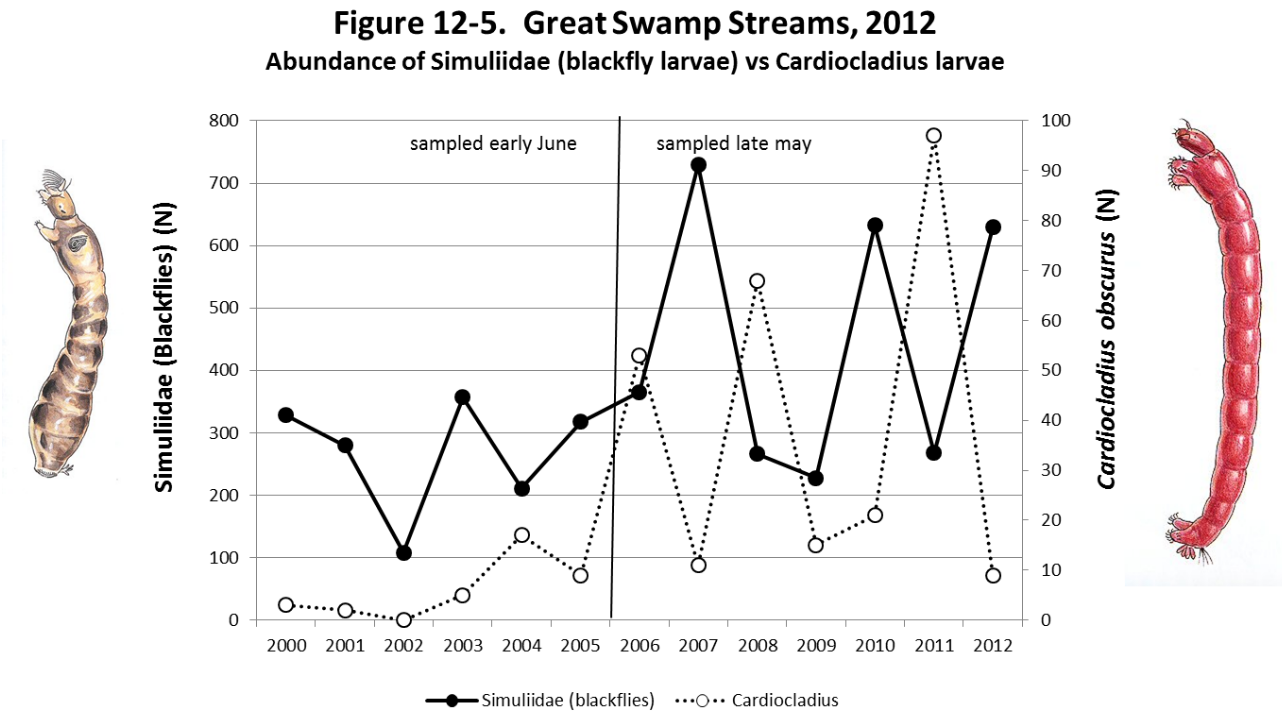
Sites along Great Brook (especially GB3, GB4, & GB5) show the greatest decline this year. Last year, we reviewed the particularly erratic changes we frequently encounter from year-to-year along this stream – especially since 2006 when we shifted sampling about 1 ½ weeks earlier, from early June into late May. We found that a predator-prey relationship between the carnivorous chironomid larva, *Cardiocladius*, and its principle prey, blackfly larvae of the dipteran (fly) family, Simuliidae accounted for a significant part of these annually fluctuating scores. As blackfly abundance rises, it often leads to an increase in the Dominance (DOM) component of the B-IBI score – i.e., the portion of the community comprised of the two most abundant species. Since overpowering dominance by a few species is seen as a detrimental



characteristic of MIV communities, this change can account for a decline of 2 or more points in high blackfly years. Blackfly larvae appear to increase especially in years when their predators are scarce. Fewer *Cardiocladius* influences the Proportion of Predators (PPred) component of B-IBI. Because predators can only do well in robust and healthy conditions, their decline is also considered a negative feature, and can result in a further 2 or more point decline due to this factor. Conversely, in years of predator abundance (a positive community characteristic), there tends to be fewer of their prey, reducing dominance (another positive community feature), and the B-IBI rises by several points.

As may be seen in Figure 12-5, in a reverse of circumstances observed in 2011, 2012 was a favorable year for blackfly larvae but not for *Cardiocladius*. In consequence, a look at Table 12-3 shows that increases in the Dominance (DOM) component caused the B-IBI score to fall at all 4 Great Brook sites and a drop in the Proportion Predators (PPRED) component led to further declines at all but GB2. So once again, this relationship appears to explains most of the variability at Great Brook.

The MIV community at LB3, located below the Morris Township STP in a setting of very poor substrate diversity, was dominated by enchytraid worms, accounting for more than ½ of the individuals encountered there. The total absence of predators there also pulled down the B-IBI Score. The MIV community at PB2 was about equal to that seen in 2011, but that means that the B-IBI score remained at 30 – a comparative low for that site. As we explained in last



year's report, this site appears to host a community whose composition happens to fall right at scoring thresholds for several components of the B-IBI. This means that relatively minor shifts can lead to 2-point declines or rises in several features. In 2011, we offered hope that in 2012, small composition changes could cause to score for PB2 to jump back upward. Unfortunately, little changed and the score remained where it was. I could not detect any deterioration in environmental conditions (aside from a modest rise in turbidity – perhaps related to flow from the Mt. Kemble lake outlet just upstream, and possibly linked to the wet preceding fall) at this aesthetically lovely spot. Because of this lack of improvement, once again that puzzling situation at PB2 should receive special attention in the future.

Declines in community quality at PR2 (6 points) and PR1 (4 points) were substantial, even though they remained within 1 standard deviation of their mean values. The upper Passaic River is the largest flowing-water setting in the watershed and heavy rains can turn it into a well-known, significant force. In 2012, probably as a result of the Hurricane Irene event during the preceding fall, we found that virtually all of the rocky substrate at the PR2 location (just downstream from I-287) had been washed downstream effectively obliterating the MIV-favored riffle habitat there. In response, we moved our sampling some ca. 80 yards further downstream to a new location – the first with appropriate, if comparatively limited, riffle substrate. It is likely that high water flow here and further downstream at PR1 accounts for declines in MIV community quality as they attempt to recover from severe stream-bed scour.

By observing changes in B-IBI values for each site since 2000 (see Figures 12-6a-g), we can view this year's results in another perspective – as part of trend patterns. Nearly all sites display some degree of oscillation as B-IBI components reflect observed changes in community composition over this period. The trend in nearly all cases is to hold steady or gently improve. This year, only the PB2 site, discussed in detail above, declines in noteworthy fashion. Another general pattern visible in these figures is that in all but Great Brook sites, the degree of variability in B-IBI score appears to have reduced – especially since 2006 when sampling shifted to a slightly earlier date each year.

For a final summary view, in Figure 12-7, we plot average values grouped for all the sites in each stream. Despite several score reductions in 2012, trend lines continue highlight the improving progression for all of the Great Swamp stream communities.

See Appendix 11-2 for Stream Summaries and suggestions for further action.

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Fig. 012-6a. Black Brook B-IBI Score, 2000-2012

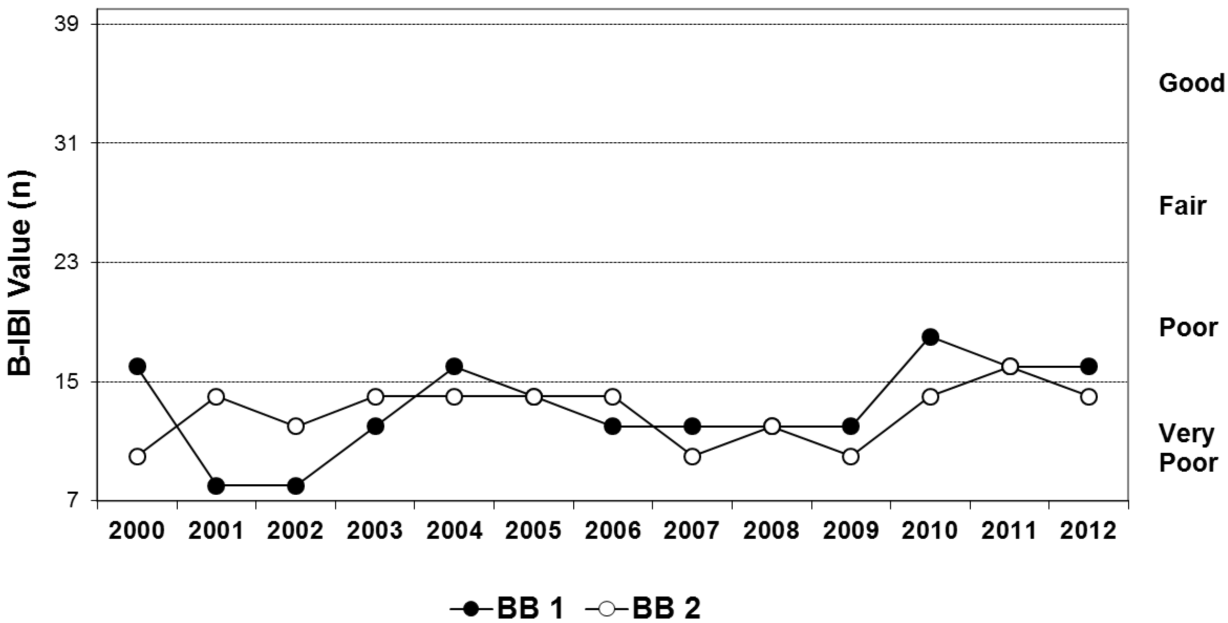


Fig. 12-6b. Loantaka Brook B-IBI Score, 2000-2012

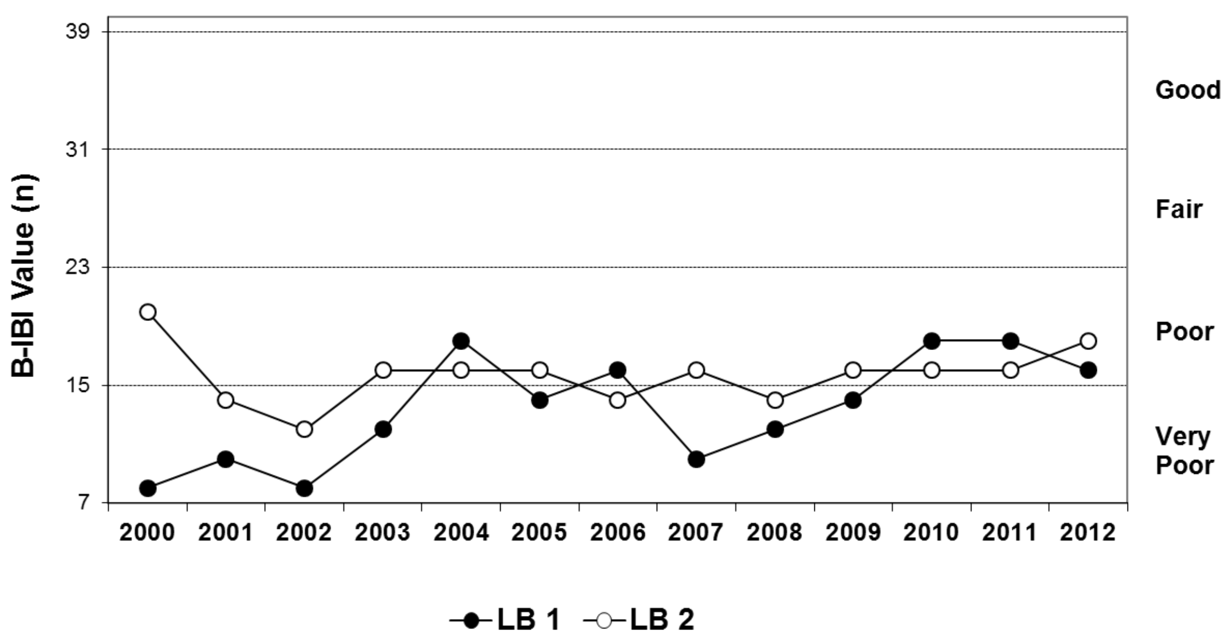


Fig. 012-6c. Loantaka Brook B-IBI Score, 2000-2012

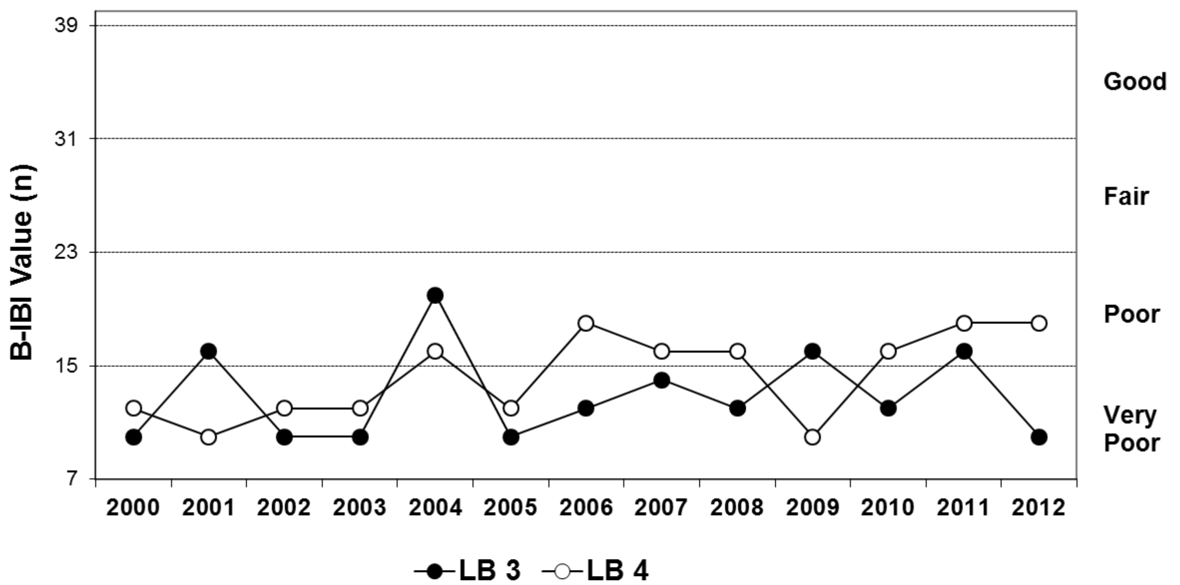
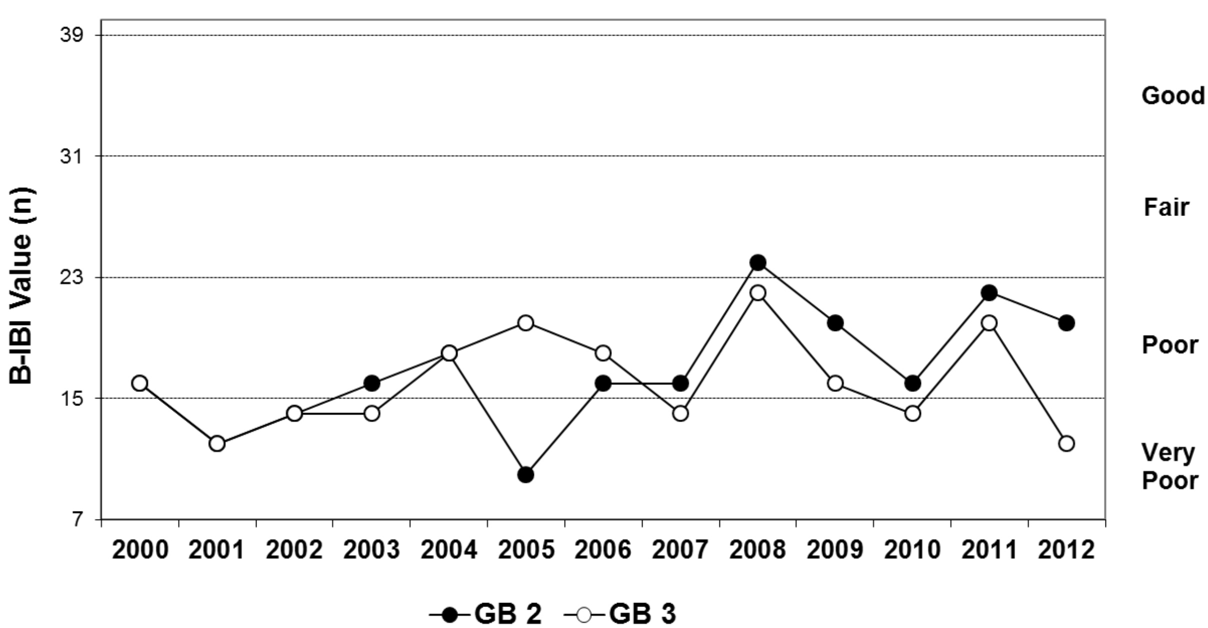


Fig. 12-6d. Great Brook B-IBI Score, 2000-2012



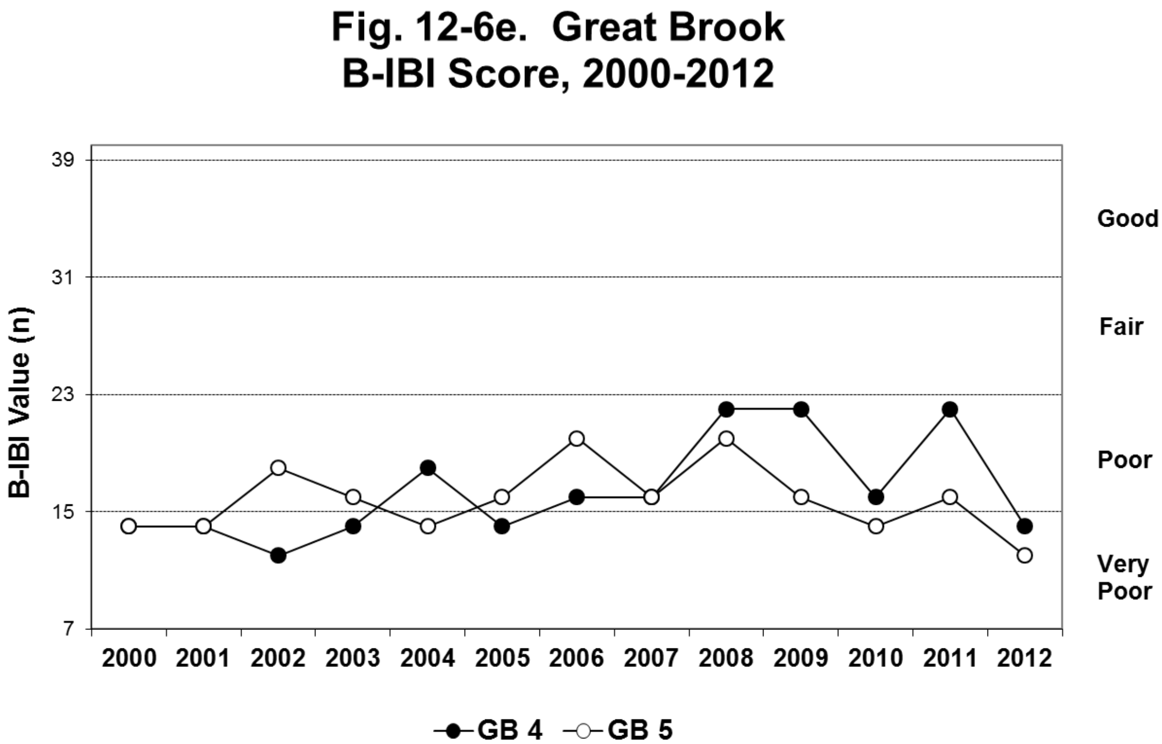


Fig. 12-6e. Great Brook
B-IBI Score, 2000-2012
B-IBI Value (n)
39
31
23
15
7
Good
Fair
Poor
Very Poor
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
GB 4
GB 5

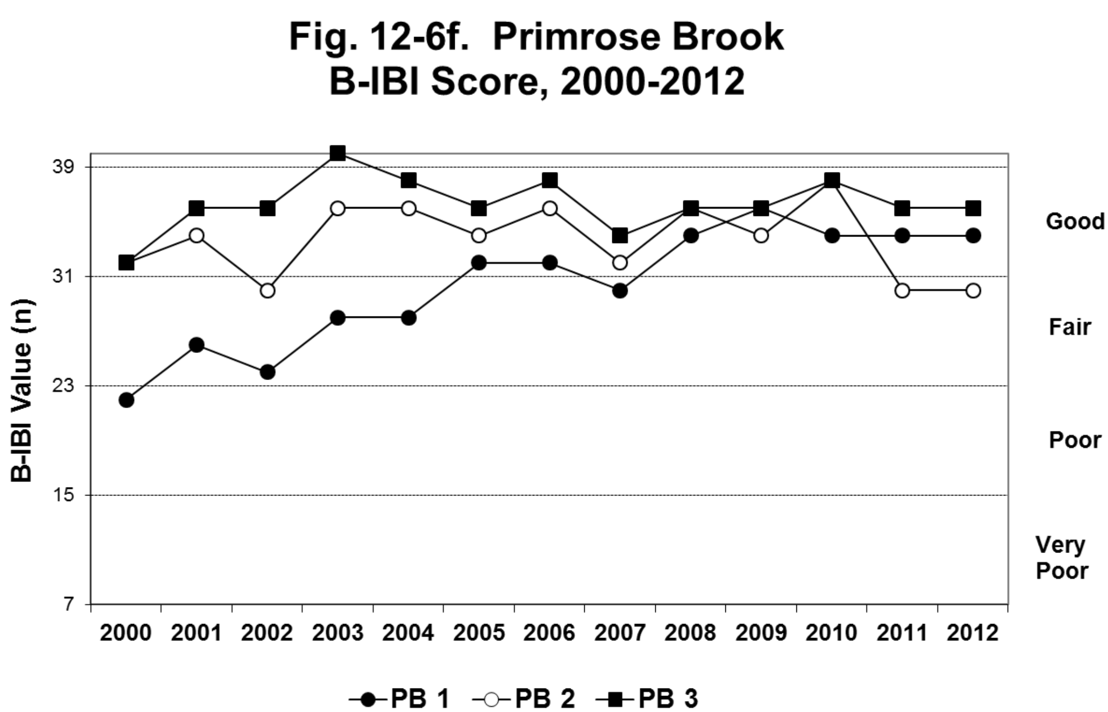
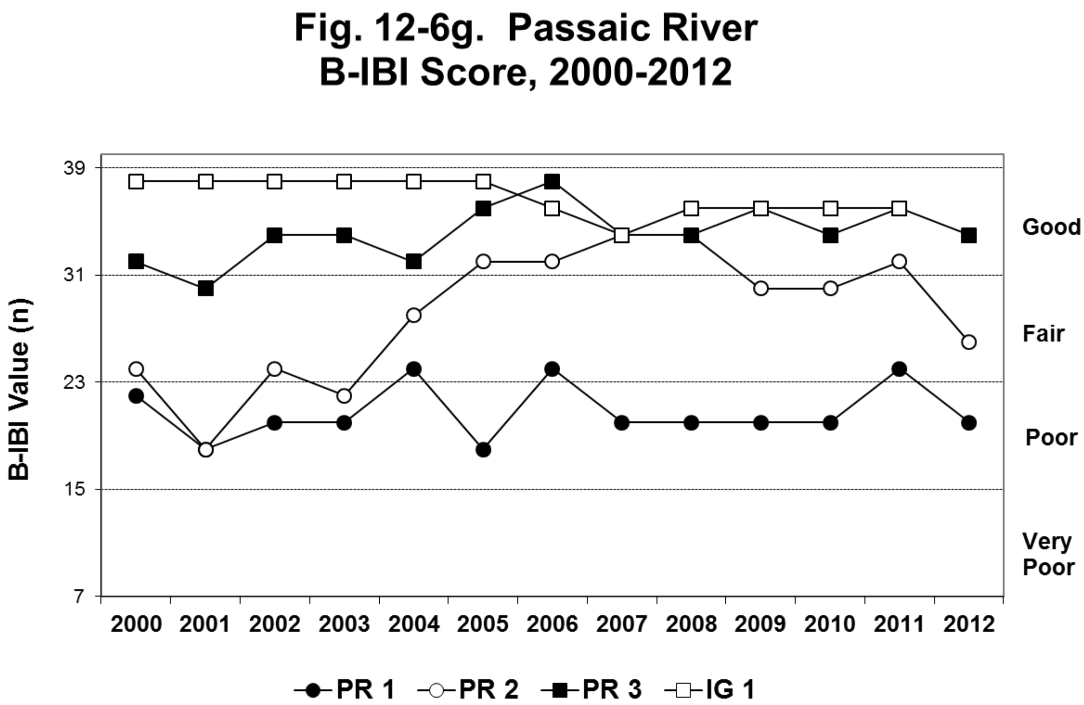
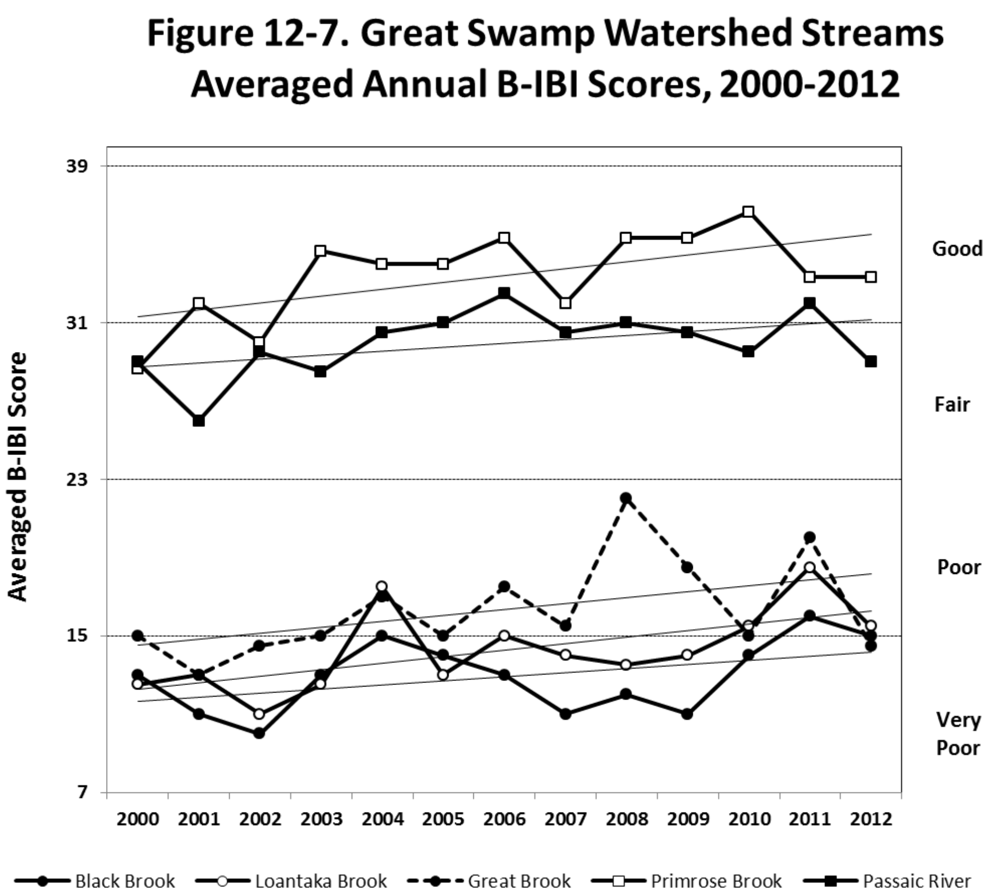


Fig. 12-6f. Primrose Brook
B-IBI Score, 2000-2012
B-IBI Value (n)
39
31
23
15
7
Good
Fair
Poor
Very Poor
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
PB 1
PB 2
PB 3



The June 2011 Great Swamp Watershed Study:



Recommendations

1. With 21 years of unbroken annual data on Great Swamp Watershed streams, continuing to monitor these 17 sampling sites carries significant regional value.
2. A series of stream-site specific recommendations have been made below in the Stream Summaries section of this report (Appendix 12-2).
3. We have highlighted issues to be alert to in 2012 sampling. They include:

   -- High TDS levels at GB4 & 5, BB2, and at and above LB4.

   -- Continue to keep an eye on the comparatively low B-IBI score at PB2 – is it a consequence of minor changes in threshold community members or does it signify something more important?

   --Noting the impact of simulid/Cardiocladius predator/prey relations on B-IBI scores for Great Brook.

   --Monitoring the recovery of Hurricane-scoured sites, PR2 & 1.

Works Cited

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Pollock, L. W. 2012. The Macroinvertebrate Communities of the Great Swamp Watershed, 2011: Results. A Report to the Ten Towns Great Swamp Management Committee. 23 pages including 11 figures, 5 tables, 2 appendices

Acknowledgments

I am grateful to the Great Swamp Watershed Association (GSWA) for their understanding of the value of using macroinvertebrate communities to document water quality conditions throughout the watershed by making it possible for these studies to continue. In addition I acknowledge the generous, in-kind support of my home institution, Drew University. Mr. Eric Senical, Program Director for the Green Mountain Conservation Group in Effingham, NH, kindly loaned me a turbidity meter to use during the environmental survey portion of this study. Laura Kelm (GSWA), Caroline Meier (Drew University), and Gene Fox (Summit, NJ) have donated their valuable volunteer help and good company during field portions of this study.

Table 12-1. Great Swamp Watershed, May 25,2011. Habitat Assessment

* Average, 2000-2008 ** Determined once

	Beck	B-IBI	width*	X depth*	X velocity*	discharge*	Gradient**	order**	%riffle	temp	TDS	DO	pH	Turbidity	
BB1	7	16	8.4	0.45	0.18	0.294	0.000	1	30	19.0	300.7	5.24	7.35	6.93	BB1
BB2	12	14	13.2	0.51	0.43	1.927	0.000	1	0	17.2	555	8.16	7.57	0.81	BB2
LB1	20	16	19.7	0.54	0.62	6.258	0.002	3	20	17.5	438.5	6.99	7.57	4.44	LB1
LB2	17	18	14.1	0.47	0.79	4.438	0.002	2	10	18.5	578	6.37	7.50	3.72	LB2
LB3	9	10	9.5	0.43	1.17	3.318	0.000	2	2	18.1	701	6.68	7.21	1.54	LB3
LB4	9	18	6.3	0.27	0.25	0.306	0.000	1	2	16.7	737	6.5	7.42	4.54	LB4
GB2	28	20	27.1	0.31	0.90	6.613	0.002	2	15	17.4	239.2	7.4	7.19	8.98	GB2
GB3	7	12	27.0	0.71	0.90	13.311	0.002	2	30	17.7	245.3	7.85	7.43	13.00	GB3
GB4	12	14	10.1	0.45	0.58	2.102	0.000	1	5	17.5	419.1	6.56	7.50	4.14	GB4
GB5	16	12	9.0	0.61	0.46	2.475	0.003	1	30	18.9	381	5.48	7.55	5.10	GB5
PB1	53	34	19.5	0.41	0.87	6.715	0.002	2	60	17.3	157.4	8.69	7.62	2.95	PB1
PB2	38	30	18.4	0.39	1.00	7.203	0.006	2	60	17.2	157.1	8.79	7.54	5.56	PB2
PB3	59	36	10.8	0.54	0.77	4.260	0.013	2	40	16.0	92.2	9.21	7.63	2.23	PB3
PR1	20	20	22.4	0.57	1.12	12.001	0.000	3	50	18.5	146	8.39	7.42	5.93	PR1
PR2	27	26	21.2	0.61	1.33	14.047	0.006	3	10	17.1	153.5	8.62	7.34	3.17	PR2
PR3	27	34	23.0	0.54	1.70	18.742	0.006	3	75	17.0	118.7	8.97	7.53	2.27	PR3
IG1	57	36	15.3	0.42	1.06	6.205	0.017	2	35	15.5	148.9	9.16	7.50	1.12	IG1
Mean	24.59	21.53	16.17	0.48	0.83	6.48	0.004	1.94	27.88	17.48	327.56	7.59	7.46	4.50	
Max	59	36	27.11	0.71	1.70	18.74	0.017	3	75	19	737	9.21	7.63	13	
Min	7	10	6.33	0.27	0.18	0.29	0.000	1	0	15.5	92.2	5.24	7.19	0.81	

	Beck	B-IBI	cover	embed	regim	sedim	flow	chann	riffle	bank	veget	ripar	total	HabValue2	
BB1	7	16	9	11	12	3	14	3	8	5	6	4	75	33	BB1
BB2	12	14	3	3	15	1	14	4	2	6	10	18	76	22	BB2
LB1	20	16	7	2	12	2	14	8	3	5	4	5	62	16	LB1
LB2	17	18	12	7	14	12	14	8	9	4	4	14	98	36	LB2
LB3	9	10	1	2	10	3	13	12	2	5	5	13	66	17	LB3
LB4	9	18	8	2	7	2	14	5	1	7	10	4	60	22	LB4
GB2	28	20	4	4	13	2	14	6	16	8	9	4	80	39	GB2
GB3	7	12	18	15	19	16	14	12	15	11	11	4	135	68	GB3
GB4	12	14	10	4	10	2	14	5	10	5	10	6	76	31	GB4
GB5	16	12	9	6	16	3	14	3	13	7	13	12	96	42	GB5
PB1	53	34	16	10	16	8	14	9	14	8	12	9	116	52	PB1
PB2	38	30	15	9	16	10	14	18	20	9	8	17	136	56	PB2
PB3	59	36	20	18	20	18	15	13	18	9	10	20	161	73	PB3
PR1	20	20	3	4	14	12	14	13	16	12	13	20	121	57	PR1
PR2	27	26	7	4	5	5	16	5	0	8	7	20	77	24	PR2
PR3	27	34	19	18	20	17	14	10	18	15	13	13	157	81	PR3
IG1	57	36	19	18	20	18	14	9	17	14	18	6	153	85	IG1
Mean	24.59	21.53	10.59	8.06	14.06	7.88	14.12	8.41	10.71	8.12	9.59	11.12	102.65	44.35	
Max	59	36	20	18	20	18	16	18	20	15	18	20	161	85	
Min	7	10	1	2	5	1	13	3	0	4	4	4	60	16	

Table 11-2. Great Swamp Watershed, Summary of Environmental Data 2009-2011

$\boxed{\text{stressful conditions*}}$

	Beck			B-IBI			Temperature			TDS			
	2011	2010	2009	2011	2010	2009	2011	2010	2009	2011	2010	2009	
BB1	**5**	9	**7**	**16**	14	**12**	**21.2**	22.4	15.7	381.7	308	266	**BB1**
BB2	**10**	**5**	**5**	16	14	**10**	16.8	18.4	16	592	534	488	**BB2**
LB1	26	20	19	18	18	14	19.2	22.0	19.6	517	564	330	**LB1**
LB2	13	16	15	**16**	16	16	20.0	**23.4**	**22.2**	**680**	**658**	468	**LB2**
LB3	15	**7**	11	20	**12**	16	17.5	20.2	19.1	**756**	**698**	**582**	**LB3**
LB4	**5**	11	**2**	20	16	**10**	18.0	20.7	19	**906**	**875**	**770**	**LB4**
GB2	23	22	21	22	16	20	18.4	21.5	19.9	246.1	256	497	**GB2**
GB3	13	13	21	20	14	16	19.0	22.7	**24**	254.8	267	**533**	**GB3**
GB4	20	15	16	22	16	22	19.7	21.3	18	304	354	384	**GB4**
GB5	17	17	15	**16**	14	16	**21.0**	**24.4**	**22.4**	498	357	233	**GB5**
PB1	44	50	49	34	34	36	18.0	20.1	18.6	148.7	122	249	**PB1**
PB2	44	52	42	30	38	34	18.0	19.7	18.6	145.5	121	248	**PB2**
PB3	53	57	51	36	38	36	17.0	20.9	18.9	90	76	148	**PB3**
PR1	27	22	36	24	20	20	**21.0**	22.5	18.75	170.6	130	136	**PR1**
PR2	43	32	37	32	30	30	**20.5**	21.0	15.5	157	126	120	**PR2**
PR3	43	32	37	36	32	36	18.9	20.6	20.4	144.4	112	253	**PR3**
IG1	63	60	70	36	36	36	18.3	20.6	17.5	157.9	118	229	**IG1**
mean	27.29	25.88	26.71	24.35	22.24	22.35	18.97	21.32	19.07	361.75	333.88	349	**mean**
max	63	60	70	36	38	36.00	21.2	24.4	24.00	906	875	770	**max**
min	5	5	2	16	12	10.00	16.8	18.4	15.50	90	76	120	**min**

	DO			pH			Turbidity			Habitat Value			
	2011	2010	2009	2011	2010	2009	2011	2010	2009	2011	2010	2009	
BB1	**5.43**	**4.6**	7.59	7.04	6.81	7.67	**9.99**	1.81	6.95	27	40	31	**BB1**
BB2	8.8	8.7	**5.6**	6.87	**6.29**	7.13	4.42	2.06	1.48	22	31	26	**BB2**
LB1	7.73	**6.44**	7.02	7.22	7.11	7.62	4.87	4.07	6.37	19	30	**10**	**LB1**
LB2	7.67	7.74	6.85	7.31	7.70	7.42	3.21	4.18	3.82	24	42	41	**LB2**
LB3	7.4	6.66	6.7	7.30	7.34	7.01	1.19	1.57	1.93	**7**	**26**	**7**	**LB3**
LB4	8.13	7.5	7.29	7.44	7.54	7.45	5.01	4.37	5.55	**15**	18	**17**	**LB4**
GB2	8.43	7.13	7.58	7.32	7.29	7.68	5.79	3.78	6.20	34	40	38	**GB2**
GB3	8.6	8.02	6.92	7.40	7.58	8.07	**8.13**	2.87	4.09	58	78	69	**GB3**
GB4	6.94	7.12	**5.9**	7.57	7.64	7.41	4.24	2.77	3.73	20	**21**	20	**GB4**
GB5	7.96	6.95	7.07	7.58	7.65	7.3	4.64	**8.72**	5.12	38	42	37	**GB5**
PB1	9.31	8.78	8.67	7.35	7.79	7.69	1.76	1.97	5.38	68	63	57	**PB1**
PB2	9.35	9	8.55	7.42	7.78	7.7	1.92	2.07	7.17	63	65	67	**PB2**
PB3	9.88	9.25	8.67	7.84	8.01	7.73	2.09	2.47	2.79	75	65	71	**PB3**
PR1	9.6	9.73	10.27	7.58	7.95	6.89	3.79	3.57	**8.70**	46	52	49	**PR1**
PR2	8.98	9.14	9.87	7.38	7.78	6.81	**8.14**	2.52	**8.77**	40	34	42	**PR2**
PR3	9.15	9.35	8.55	7.50	7.81	7.68	1.85	1.03	3.53	77	84	81	**PR3**
IG1	9.23	9.3	9	7.51	7.68	7.66	1.68	1.01	1.26	79	84	82	**IG1**
mean	8.39	7.97	7.77	7.39	7.51	7.47	4.28	2.99	4.87	41.88	48.47	43.82	**mean**
max	9.88	9.73	10.27	7.84	8.01	8.07	9.99	8.72	8.77	79	84	82.00	**max**
min	5.43	4.6	5.6	6.87	6.29	6.81	1.19	1.01	1.26	7	21	7.00	**min**

*> 1 STD above or below the mean

Table 12-3. Comparison between B-IBI components, 2011 and 2012

declined
improved

	BB1		BB2		LB1		LB2		LB3		LB4	
Data	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
DOM	0.64	0.811594	0.422111	0.648515	0.55814	0.59116	0.386719	0.713592	0.616505	0.81268	0.433498	0.677419
TAXA	14	12	15	18	24	14	18	16	15	13	12	12
PPred	0.336735	0.04878	0.011538	0	0.011538	0	0.080645	0.009709	0.039604	0	0.059091	0.252874
IndIntol	0	0	1	3	1	0	0	2	0	0	0	1
#Eph	0	0	0	0	3	0	0	0	0	0	0	0
#Trich	1	2	1	0	1	2	1	3	0	1	1	1
#Plec	0	0	0	0	0	0	0	0	0	0	0	0
IndTol	7	4	3	6	4	3	7	3	3	5	2	4
B-IBI Scores	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**		**2011**	**2012**
DOM	3	***1***	5	***3***	3	3	5	***3***	3	***1***	5	***3***
TAXA	3	3	3	3	5	***3***	3	3	3	3	3	3
PPred	5	***3***	1	1	1	1	3	***1***	3	***1***	3	**5**
IndIntol	1	1	1	**3**	1	1	1	**3**	1	1	1	1
#Eph	1	1	1	1	3	***1***	1	1	1	1	1	1
#Trich	1	**3**	1	1	1	**3**	1	**3**	1	1	1	1
#Plec	1	1	1	1	1	1	1	1	1	1	1	1
IndTol	1	**3**	3	***1***	3	3	1	**3**	3	***1***	3	3
B-IBI Total	**16**	**16**	**16**	**14**	**18**	**16**	**16**	**18**	**16**	**10**	**18**	**18**

	GB2		GB3		GB4		GB5		PB1		PB2	
Data	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
DOM	0.417778	0.530806	0.46798	0.853982	0.397059	0.695853	0.579832	0.834711	0.295775	0.41	0.548872	0.275132
TAXA	20	24	15	11	26	18	20	15	34	33	30	29
PPred	0.035714	0.038647	0.167488	0.07489	0.108911	0.017937	0.100478	0.048309	0.100478	0.048309	0.086466	0.085714
IndIntol	1	3	0	1	2	1	0	0	7	7	9	4
#Eph	2	1	1	0	0	0	1	0	5	4	5	5
#Trich	2	2	2	1	0	2	1	1	6	7	7	5
#Plec	0	1	0	0	0	0	0	0	4	5	4	4
IndTol	3	5	6	4	5	6	6	6	3	4	2	3
B-IBI Scores	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
DOM	5	***3***	5	***1***	5	***3***	3	***1***	5	5	3	**5**
TAXA	3	**5**	3	***1***	5	***3***	3	3	5	5	5	5
PPred	3	3	5	***3***	5	***1***	5	***3***	5	***3***	3	3
IndIntol	1	**3**	1	1	3	***1***	1	1	5	5	5	5
#Eph	3	***1***	1	1	1	1	1	1	3	3	3	3
#Trich	3	3	3	***1***	1	**3**	1	1	5	5	5	***3***
#Plec	1	1	1	1	1	1	1	1	3	**5**	3	3
IndTol	3	***1***	1	**3**	1	1	1	1	3	3	3	3
B-IBI Total	**22**	**20**	**20**	**12**	**22**	**14**	**16**	**12**	**34**	**34**	**30**	**30**

	PB3		PR1		PR2		PR3		IG1	
Data	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
DOM	0.385	0.25	0.461187	0.714286	0.244541	0.425	0.429864	0.234742	0.316456	0.310502
TAXA	36	39	19	17	30	25	38	32	39	34
PPred	0.075	0.161572	0.03653	0.004167	0.085586	0.071429	0.134259	0.072072	0.090476	0.105556
IndIntol	9	7	2	2	6	3	10	4	8	10
#Eph	6	5	2	2	7	4	8	3	6	5
#Trich	6	9	3	3	7	2	7	7	9	9
#Plec	8	8	1	0	1	2	4	6	6	7
IndTol	3	2	4	3	4	8	3	3	3	4
B-IBI Scores	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
DOM	5	5	5	***3***	5	5	5	5	5	5
TAXA	5	5	3	3	5	5	5	5	5	5
PPred	3	**5**	3	***1***	3	3	5	***3***	3	**5**
IndIntol	5	5	3	3	5	***3***	5	5	5	5
#Eph	5	***3***	3	3	5	***3***	5	***3***	5	***3***
#Trich	5	5	3	3	5	***3***	5	5	5	5
#Plec	5	5	1	1	1	**3**	3	***5***	5	5
IndTol	3	3	3	3	3	***1***	3	3	3	3
B-IBI Total	**36**	**36**	**24**	**20**	**32**	**26**	**36**	**34**	**36**	**36**

Appendix 12-1. Great Swamp, 2012	BB1	BB2	LB1	LB2	LB3	LB4	GB2	GB3	GB4	GB5	PB1	PB2	PB3	PR1	PR2	PR3	IG1	Totals
Ann:Hirudinea:Glossiphoniidae: Helobdella sp 1	2																	2
Ann:Hirudinea:Glossiphoniidae: Helobdella sp 2										1					1			2
Ann:Hirudinea:Erpobdellidae: Mooreobdella sp 1		2					1			1								4
Ann:Hirudinea:Erpobdellidae: Mooreobdella sp 2				1				1		10					1			13
Ann:Oligochaeta:Enchytraidae	1	18			210	12			1		14	18	1	1	22	9	6	313
Ann:Oligochaeta:Lumbricidae							3		1			5						9
Col:Elmidae: sp 1 larva				4														4
Col:Elmidae: sp 2 larva							2						1			3	1	7
Col:Elmidae, sp 3 larva			1								2	4	3					10
Col:Elmidae: Stenelmis - adult			19		1		18		1		4	1	5	3		4		56
Col:Elmidae: Stenelmis sp 1 - larva			7	1	1	4	13			3	8		2	4		5	4	52
Col:Elmidae: sp 4 larva							1										6	7
Col:Elmidae: Promoresia sp 1 larva											1					1	2	4
Col:Elmidae: Stenelmis sp 2 - larva			1	6			7											14
Col:Elmidae: sp 5 larva							1											1
Col:Elmidae: Stenelmis sp 3 - larva				1			5		6		1					1		14
Col:Hydrophilidae: Anacaena																		0
Col:Elmidae:Macronyches			1									1						2
Col:Psephenidae: Ectopria - larva											1		1		1			3
Col:Psephenidae: Psephenus - larva											7	2	2	3	1	6	9	30
Cru:Ostracoda		18								15						1		34
Cru:Amphipoda:Gammaridae: Gammarus faciatus		86	84	108	29	2	45	5	22	20	6	5		48	53	2	12	527
Cru:Dec: Cambarus spp													1		1			2
Cru:Isopoda: Caecidotea			9						3			1			2			15
Dip:Athericidae: Atherix													2			1		3
Dip:Chironomidae:Chironomini: Dicrotendipes								5										5
Dip:Chironomidae:Orthocladini: Eukiefferiella sp 1									7				7					14
Dip:Chironomidae:Orthocladini: Eukiefferiella sp 2						4												4
Dip:Chironomidae:Orthocladini: Eukiefferiella sp 3			9		2						7	3						21
Dip:Chironomidae:Orthocladini: Cricotopus sp 1			7															7
Dip:Chironomidae:Orthocladini: Orthocladius														1				1
Dip:Chironomidae:Orthocladini: Cardiocladius									3						3	3		9
Dip:Chironomidae:Orthocladini: Cricotopus sp 2									8									8
Dip:Chironomidae:Chironomini: Polypedilum sp 1	13	10		10	7			10		4	10	33	2	2	32	21	2	156
Dip:Chironomidae:Chironomini: Polypedilum sp 2					1				3									4
Dip:Chironomidae:Chironomini: Cryptochironomus							1											1
Dip:Chironomidae:Orthocladini: Cricotopus sp 3	7																	7
Dip:Chironomidae:Chironomini: Microtendipes			22				12				1				1			36
Dip:Chironomidae:Chironomini: Chironomus		1			1	82												84
Dip:Chironomidae:Tanypodini:Thienemannimyia spp	8	1		1		44	4	11	1	2	1	2	18		4			97
Dip:Chironomidae:Orthocladini: Rheocricotopus							6							2				8
Dip:Chironomidae:Tanypodini: Tanytarsus sp 1	7	6			1		6		2						15			37
Dip:Chironomidae:Tanypodini: Tanytarsus sp 2						2							1	2				5
Dip:Chironomidae:Diamesinae: Potthastia	1																	1
Dip:Chironomidae:Tanypodini: Pentaneura												1						1
Dip:Chironomidae: pupa	3	2			1	12	4		1			2	2		4	6		37
Dip:Culicidae pupa		1																1
Dip:Tendipidae: pupa				1														1
Dip:Simuliidae: Simulium spp				22	18	8	14	182	100	182	2		28	27	27	17	2	629
Dip:Simuliidae: pupa											1							1
Dip:Tipulidae: Hexatoma		1																1
Dip:Tabanidae larva							2											2
Dip: Tipulidae: Tipula sp 1		6		3		2		2	1									14
Dip:Tipulidae: Antocha - larva														2			1	3
Dip:Tipulidae: Tipula sp 2		1															1	2
Eph:Baetidae: Pseudocloeon																	1	1
Eph:Baetidae: Baetis sp 1											8	16	7	1		14		46
Eph:Baetidae: Baetis sp 2							2				11	10	12		3	18	35	91
Eph:Ephemerellidae: Attenella																	1	1
Eph:Ephemerellidae: Timpanoga (Dannella)											3	16	4					23
Eph:Ephemerellidae: Serratella sp 1																	3	3
Eph:Ephemerellidae:Serratella sp 2													9					9
Eph:Heptageniidae:Stenacron															1			1
Eph:Heptageniidae: Stenonema sp 1																	1	1
Eph:Heptageniidae: Stenonena sp 1											6	2	6	2	18	3		37
Eph:Isonychiidae: Isonychia												1						1
Eph:Leptophelbiidae: Paraleptophlebia															1			1
Collembola																1		1
Lepidoptera		1																1
Spongillidae, Sysra								1										1
Meg:Corydalidae: Chauloides											1							1
Meg: Nigronia serricornis											2	1	2			1		6
Mol:Bivalvia:Sphaeriidae: Sphaerium spp	2	6	1		3		1	2		1								16
Mol:Bivalvia: Corbicula			23															23
Mol:Gastropoda:Pulmonata:Physidae: Physella sp 1	7	13	7			10	3			12	1				2		1	56
Mol:Gastropoda:Prosobranchia:Limacidae: Amnicola										1								1
Mol:Gastropoda:Pulmonata:Planorbidae: Gyraulus		2								3								5
Mol:Gastropoda:Pulmonata:Planorbidae: Helisoma				3														3
Mol:Gastropoda:Pulmonata:Planorbidae: Planorbula sp 1				1					1									2
Mol:Gastropoda:Pulmonata:Planorbidae: Planorbella sp 2										1								1
Nematoda												1			1		2	4
Odo:Anisoptera:Gomphidae: Lanthus													1		2			3
Odo:Anisoptera:Boyeria														1				1
Odo:Zygoptera:Coenagrionidae: Amphiagrion							1											1
Pla:Planariidae: Dugesia		45						5										50
Ple:Capniidae:Allocapnia													2					2
Ple:Chloroperlidae: Suwallia													1					1
Ple:Leuctridae: Leuctra											2	2	3			3	31	41
Ple:Leuctridae: Paraleuctra													1			2		3
Ple:Perlidae: Perlesta							1					3	4		2		3	13
Ple:Perlidae: Agnetina sp 1																	4	4
Ple:Perlidae: Acroneuria sp 1											1							1
Ple:Perlidae: Agnetina sp 2																1	7	8
Ple:Perlidae: Paragnetina																	2	2
Ple:Perlisdae: Hansonoperla											1		1					2
Ple:Perlidae: Acroneuria sp 2											1	5	1			6	1	14
Ple:Perldae: Acroneuria sp 3											1		2					3
Ple:Perlotidae: Isoperla												1			1	1		3
Ple:Pteronarcyidae: Pteronarcys																2	1	3
Tri:Brachycentridae: Micrasema											1						2	3
Tri:Glossosomatidae: Glossosoma											3	17	2	1		22	30	75
Tri:Goeridae: Goera																1		1
Tri:Hydropsychidae: Chaeumatopsyche	155		11	39	72	4	67	3	51	1	62	19	21	122	1	22		650
Tri:Hydropsychidae: Hydropsyche	1		1	3					5	6	20	6	26	16	1	4	33	122
Tri:Hydropsychidae: Diplectrona													2				4	6
Tri:Lepidostomatidae: Theliopsyche												6	1					7
Tri:Limnephilidae: Theliopsyche											7						1	8
Tri:Philopotamidae: Chimarra							3											3
Tri:Philopotamidae: Dolophilodes				2							2		21			28	3	56
Tri: Polycentropodidae: Cyrnellus																	1	1
Tri:Polycentropodidae: Polycentropus													5					5
Tri:Polycentropodidae: Cernotina													1					1
Tri:Psychomyiidae: Lype																2	4	6
Tri:Rhyacophilidae: Rhyacophila											2	5	5			3	2	17
#indiv	207	220	203	206	347	186	223	227	217	263	201	189	216	238	201	214	219	3777
#spp	12	18	15	15	13	12	24	11	18	16	31	27	34	17	26	29	34	
B-IBI	16	14	16	18	10	18	20	12	14	12	34	30	36	20	26	34	36	
	BB1	BB2	LB1	LB2	LB3	LB4	GB2	GB3	GB4	GB5	PB1	PB2	PB3	PR1	PR2	PR3	IG1	